PAPERS ON CLIMATOLOGY IN RELATION TO AGRICULTURE, TRANSPORTATION, WATER RESOURCES, ETC.

THE EXPERIMENT STATION AT WAGON WHEEL GAP, COLO.

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Of the many problems relating to the conservation of the natural resources of the United States, none has been productive of such diversity of opinion, and none has been the subject of more discussion than that relating to the effects of forestation or deforestation upon water supply and water control. Those who have followed the discussions in the various conventions, meetings, and publications are aware that they have at all times been vigorous, and, unfortunately, at times more or less acrimonious. The line of cleavage is sharply defined and the advocates of neither side are willing to admit that there is much soundness in the position assumed by the other. Apparently there is not middle ground of sufficient area for both sides to stand securely upon, and the only hope of satisfactory compromise lies in the mutual admission that the whole general question is more or less problematical, and that insufficient data and different methods of discussing the same may have operated to produce widely divergent conclusions. Further research and impartial investigation are necessary in order that the real truth may be disclosed, and the establishment of the truth upon the firm foundation of accurate and unquestioned data must inevitably result in incalculable benefit to all students of the question of water supply and other allied problems and to the country at large. Therefore, the Weather Bureau and the Forest Service of the Department of Agriculture have, by permission of the Secretary of Agriculture, mutually agreed to cooperate in an exhaustive study of the whole question of the effects of forestation and deforestation upon water supply and control and upon other meteorological conditions, and in pursuance of this agreement it was determined to select two small watersheds in the same locality that should be nearly alike as to topography and extent of forestation, and with a running stream in each. The Forest Service after careful investigation suggested as a suitable field two small watersheds in the Rio Grande National Forest in southwest Colorado. Their exact location is between one and two miles west of the Wagon Wheel Gap station of the Denver and Rio Grande Railroad, and 313 miles by rail from Denver (latitude 37° 45′ N., and longitude 106° 50′ W.). The selection was agreed to by the Weather Bureau, and, after inspection, approved by the United States Geological Survey as being admirably adapted for the proposed work. The area of the south watershed is 222.7 acres and that of the north watershed 212.3 acres.

The Rio Grande in the neighborhood of Wagon Wheel Gap flows to the southward in a narrow valley between two ranges of the Rocky Mountains. The range to eastward of the river, rises rather abruptly to a plateau at a height of 11,000 feet, beyond which another abrupt rise reaches above timber line to a height of approximately 14,000 feet above sea level. The range to the westward of the river rises gradually to a height of 11,000 feet. This range, as seen from a distance, is corrugated with watercourses, similar in general character, and all leading eastward from near the top of the range toward the river.

The soil of the watersheds under study is sandy with a few isolated rock slides. The slopes average about thirty degrees, and there are no perpendicular cliffs. Each watershed contains two distinct slopes, that part to the south of the stream sloping toward the north, and being fairly well timbered, while that part sloping toward the south is less heavily timbered, probably because the greater evaporation on the southern slopes reduces the supply of moisture to a point below that required for normal growth. This change in the character of the vegetation on the different slopes is evident throughout the region.

The lower portions of the two watersheds, for a distance of a mile from the river, are grassed over with wild bunch grass, except in the immediate vicinity of the streams. For this reason the dams for the measurement of streamflow are located above the bunch-grass region, well into the forest area.

The most widely distributed of the forest cover is the aspen, which in places where the slope is slight, or where protection from evaporation exists, grows to a height of 30 feet, and is from 4 to 6 inches in diameter. In localities exposed to strong evaporation the aspen is dwarfed, and may be only 10 feet in height. Below the 10,300-foot level contour lines the forest is mostly aspen, Douglas fir, balsam, and some Engleman spruce. In many portions of the aspen forest there are evidences of young fir and spruce reproduction. From the 10,300 to the 10,800-foot contour line aspen predominates with spruce, cone-pine, and fir intermingled.

Above the 10,800-foot contour line is an area that was burned over 17 years ago. This area was evidently the most heavily timbered portions of the watersheds at that time, as indicated by the dead, standing timber and by the fallen logs, practically all Engleman spruce. A continuation of the same forest nearby, which for some reason was not touched by the fire, affords a good idea of the density of this Engleman forest before the fire. There are now some scattered stands of aspen in the burned-over region.

The work of preparation was begun in June of the present year, but owing to the many difficulties occasioned by the isolated location of the forest, it is very probable that the actual observational work can not be inaugurated until about the beginning of the coming winter. The details of the proposed campaign are as follows: Identical observations will be taken continuously and simultaneously over each watershed, and will be carried on for a series of years, possibly as many as ten. In any event the period will be of sufficient length to cover the widest variations of meteorological conditions. At the conclusion of the first period of observations one of the watersheds will be deforested and a second series of observations, equal in length to the first, will be made. The data obtained will be carefully tabulated and analyzed from time to time, and at the end of the second series of observations a comparative study and discussion of both sets of data will be made. It is believed that this method will not be open to serious objections. The equipment and personnel will be of the highest character, the observations will be made jointly by representatives of the Weather Bureau and the Forest Service, and the data should speak for themselves.

Stations of observation will be located as follows:

1. A principal station of observation 400 feet north of the main office building, (elevation about 9,250 feet above sea level), between the two watersheds, and at the foot of the timbered areas, looking east toward the Rio Grande, which runs at the foot of the slope in a southerly direction.

2. One station on the right bank of the south stream, approximately 1,500 feet above the principal station, and about 9,600 feet above sea level.

3. One station on the right bank of the north stream, approximately 3,500 feet above the principal station and about 9,500 feet above sea level.

4. One substation on the left bank of each stream almost directly opposite the right bank station.

5. One substation at the summit of the divide (elevation about 11,100 feet above sea level.

This makes six stations in all and observations will be made of the following phenomena:

Pressure.	Wind velocity.
Temperature of air.	Precipitation.
Temperature of water.	Sunshine.
Temperature of soil.	Clouds.
Relative humidity.	Evaporation.
Wind direction.	Snow on ground.

The instrumental equipment of each station will be as follows:

Principal station.

Barometer, mercurial.	Anemoscope.
Barograph.	Sunshine recorder.
Dry thermometer.	Rain gage.
Wet thermometer.	Snow gage.
Maximum thermometer.	Rain gage, tipping bucket.
Minimum thermometer.	Triple register for wind direction, wind velocity, precipitation, and sunshine.
Thermograph.	
Anemometer.	
Snow tubes and balance.	Snow bin.

Stations on right banks of streams.

Dry thermometer.	Thermograph.
Wet thermometer.	Anemometer.
Maximum thermometer.	Anemoscope.
Minimum thermometer.	Evaporation pans.
Water thermometer.	Snow bin.
Soil thermometer.	Rain gage.

Stations on left banks of streams.

Maximum thermometer.	Rain gage.
Minimum thermometer.	

Station at top of divide.

Maximum thermometer.	Rain gage.
Minimum thermometer.	Snow bin.
Thermograph.	

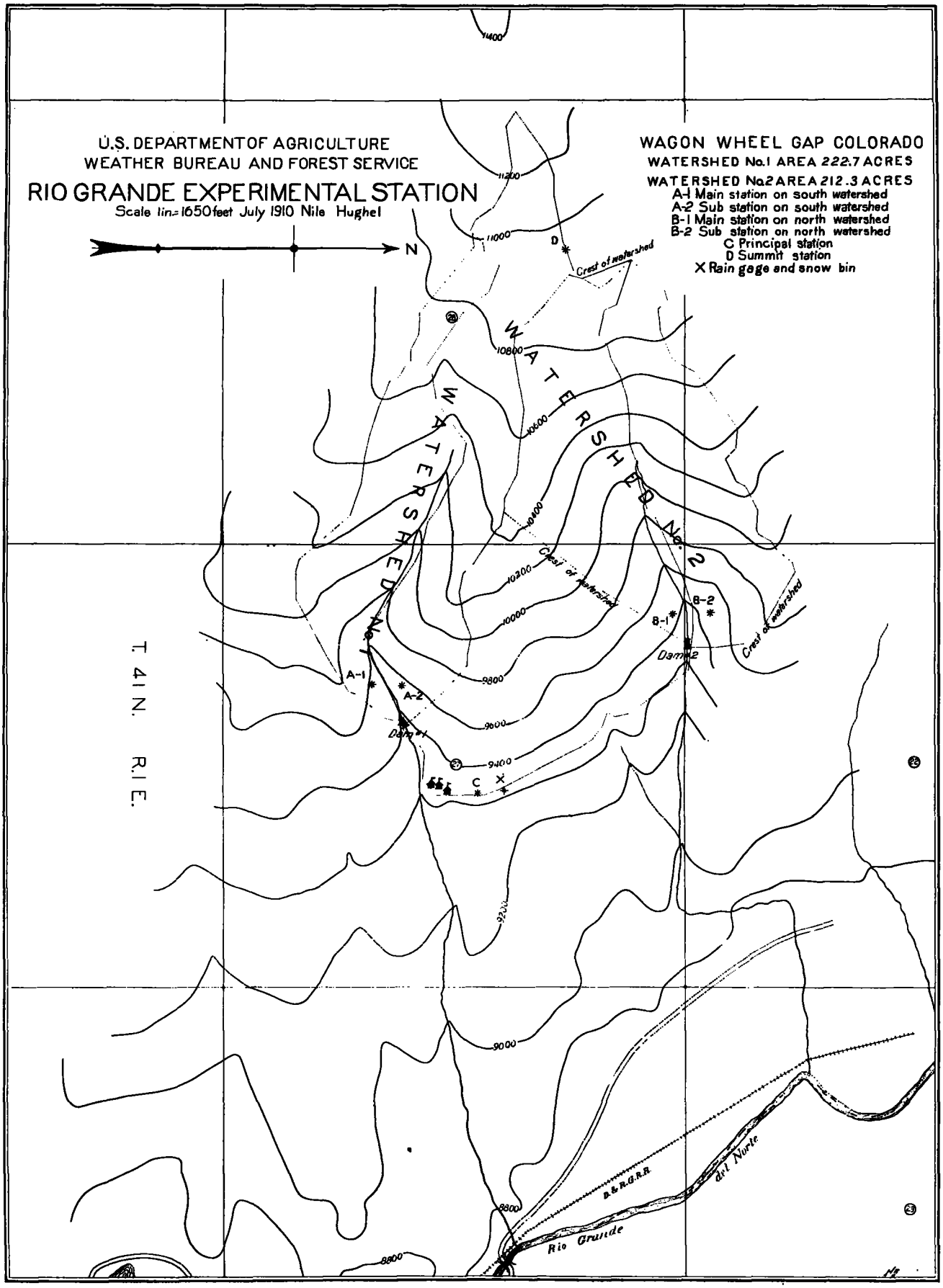
Snow scales (vertical wooden gages), probably to the number of 25 or 30, will be installed at various points throughout both watersheds, and measurements of the actual depth of snow made once each week during the snow season. The water equivalent of the snowfall will also be determined at the same time by weighing a cylindrical section of snow cut out by the snow tubes provided for that purpose.

A thorough study of the snow bin observations made during the past two years indicates the need of further experimental work in connection with the apparatus for the measurement of snowfall, and steps are in progress for the installation of a new type of shielded seasonal gage designed by Professor Marvin. The harmful effects of winds are minimized by a double system of wind shields shown to be highly effective in the experiments of Nipher, Hillmann, and others. The gage catches all forms of precipitation, rain, snow, sleet, etc., the measurement being accurately effected by weighing.

A careful study will be made of the effects of erosion, and it is also proposed to make daily observations of the ground-water level in each watershed. The necessary wells will be bored as early as possible in the spring of 1911.

For the most important part of the work, the measurement of streamflow, there have been built two dams, one in each stream, a short distance above the mouth. These dams, although small, are very substantial structures of timber and concrete, and in each there are two weirs, one of 12 inches with a 2-inch head, and another of 24 inches, placed 12 inches higher. In addition there will be a Friez Water Stage Indicator at each dam so that a continuous discharge record can be obtained with a very small percentage of errors. Hook gages will be used for very low stages.

I am indebted to Mr. B. C. Kadel, Local Forecaster, and Weather Bureau representative in charge at Wagon Wheel Gap, Colo., for the description of the watersheds and surrounding topography. See opposite page for chart showing watersheds referred to above, the location of the several points of observation and the general topography of the region.


U.S. DEPARTMENT OF AGRICULTURE
WEATHER BUREAU AND FOREST SERVICE
RIO GRANDE EXPERIMENTAL STATION
Scale 1in.=1650 feet July 1910 Nile Hughel
N
WAGON WHEEL GAP COLORADO
WATERSHED No.1 AREA 222.7 ACRES
WATERSHED No.2 AREA 212.3 ACRES
A-1 Main station on south watershed
A-2 Sub station on south watershed
B-1 Main station on north watershed
B-2 Sub station on north watershed
C Principal station
D Summit station
X Rain gage and snow bin
WATERSHED No. 1
WATERSHED No. 2
Crest of watershed
Crest of watershed
Crest of watershed
Dam No. 1
Dam No. 2
A-1
A-2
B-1
B-2
C
D
T. 41 N. R. I E.
11400
11200
11000
10800
10600
10400
10200
10000
9800
9600
9400
9200
9000
8800
8600
D. & R. G. R. R.
Rio Grande
del Norte